Rapid Assessment Reference Condition Model

The Rapid Assessment is a component of the LANDFIRE project. Reference condition models for the Rapid Assessment were created through a series of expert workshops and a peer-review process in 2004-2005. For more information, please visit www.landfire.gov. Please direct questions to helpdesk@landfire.gov.

Potential Natural Vegetation Group (PNVG):

R6RPWPif **Red Pine-White Pine with Less Frequent Fire**

General Information

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Vegetation Type

Forested

Dominant Species*

PIRE
PIST

General Model Sources

- [x] Literature
- [x] Local Data
- [x] Expert Estimate

LANDFIRE Mapping Zones

41 62
50
51

Rapid Assessment Model Zones

- [ ] California
- [ ] Great Basin
- [x] Great Lakes
- [ ] Northeast
- [ ] Northern Plains
- [ ] N-Cent.Rockies
- [ ] Pacific Northwest
- [ ] South Central
- [ ] Southeast
- [ ] S. Appalachians
- [ ] Southwest

Geographic Range

The red pine (Pinus resinosa) and white pine (Pinus strobus) cover type is found primarily throughout northern Minnesota, Wisconsin and Michigan. It has historically been the most economically important species group in the lake states region. Red pine does not naturally extend too far into the eastern United States, though it has been established in plantations as far as Pennsylvania, New York, and into the Northeast. White pine has an extensive natural range much larger than red pine and is also economically and biologically significant throughout the northeastern United States and areas extending southward at the higher elevations of the Appalachian Mountains into Northeast Georgia.

Biophysical Site Description

These red pine and white pine communities are identified by a low fire frequency. They were found in areas interspersed with lakes or other fire barriers and were located primarily in northern Wisconsin, the Upper Peninsula of Michigan, and northern Minnesota. This red-white pine community occurred within ice-contact and glaciofluvial glacial deposits with high densities of lakes, streams, and wetlands. Pitted or heavily-dissected landforms formed a complex of uplands and lowlands, and natural fuel breaks reduced the propagation of wildfire across heterogeneous landscapes (Turner et al. 1989, Motzkin et al.1999). These fire regimes were associated not only with a degree of fire protection afforded by landscape patterns (Bergeron and Brisson 1990), but also with localized edaphic conditions that affected community composition, species longevity, age at which viable seed is produced, and other physiological responses. The soils underlying this community were generally loamier and more fertile than those within the more xeric sandy soils of lower Michigan.
Within these landforms and soils, species longevity was relatively high; red pine likely had a normal maximum life expectancy of 250-300 years and white pine 300-400 years. Within forests owned by the Menominee Nation in northern Wisconsin, white pine stands less than 200 years old exhibit signs of breakup and mortality on sandy sites, whereas stands 300 to 400 years old remain intact on more mesic

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sites. In northern Minnesota, on mesic sites, red pine has been found to reach ages as old as 300 years and white pine has attained even longer life spans exceeding 400 years of age (Heinselman, 1981).

Vegetation Description

Both red pine and white pine are fire-resistant and fire-adapted species. From approximately 50 years of age and older they can withstand surface fire quite well, and the mature overstory dominants are extremely fire resistant due to their thick bark (3-4 inches). Young white and red pines are killed by surface fires, but mature red and white pines (50 to 100 years) become resistant to surface fire due to development of thick bark that protects the cambium. Both species are somewhat adapted to avoiding stand-replacing fires when mature due to development of tall crowns, as well as the wide spacing of dominant trees maintained by surface fires. However, when catastrophic crown fires do occur, mortality is high in all structural layers and survivorship depends on random variations in fire patterns resulting in unburned areas. Fifty to 100 years is required for these species to produce adequate amounts of viable seed for self-replacement; thus, crown-fire rotations of less than 50 to 100 years favor early successional species capable of sprouting or invasion (e.g., aspen and birch), as well as species capable of producing seed in short periods (e.g., jack pine and black spruce). White pine is a mid-tolerant species capable of regenerating under full-light to shaded conditions. Red pine is less tolerant than white pine, and seedlings can only survive in approximately 35 percent or more full sunlight. A large proportion of this red pine-white pine community was historically in an old growth state, with a predominantly multi-aged (Holla and Knowles 1988) or uneven-aged distribution due to continuous recruitment caused by local disturbances (Quinby 1991). Structurally, these forests were uniform with respect to tree height and diameter. During fire-free or long surface fire rotation periods, mid-tolerant white pine gained dominance through gap phase regeneration dynamics. During periods of repeated surface fires, red pine was favored due to the species' thicker bark, hence higher tolerance of fire.

Disturbance Description

This model pertains to those red and white pine systems that are maintained by infrequent surface fires and crown-fire rotations between 150-300 years. Young white and red pines are killed by surface fires, but mature white and red pines (age 50 to 100 years) become more resistant to fire disturbance due to development of thick bark that protects the cambium. Red pine develops thicker bark than white pine, and is considered more resistant to surface fire.

Forests of both species are less susceptible to stand-replacing fires when trees are mature, due to tall crowns and the wide spacing of dominant trees that is maintained by surface fires. However, when catastrophic crown fires do occur, mortality is high in all structural layers, and survivorship depends on random variations in fire patterns resulting in unburned areas. Fire rotation is best exemplified by Fire Regime Group III, with fires occurring every 50 years and low to moderate intensity surface fires most common. High intensity crown fires occur on approximately 290-year rotations. Severe wind events affect mature stands on an approximate 500-year interval. During fire-free periods or periods with long surface fire rotation, mid-tolerant white pines gain dominance through gap-phase regeneration. Heinselman (1981) suggested there are two types of red-white pine systems: those maintained by frequent surface fires and crown-fire rotation less than 150 years, and those maintained by less frequent surface fires and crown-fire rotations between 150-300 years. In the former, even-aged stands dominate, whereas in the latter, multi-aged white pine systems develop. This description applies to red-white pine communities occurring within landscape ecosystems with properties resulting in long (150-300 year) stand-replacing fire rotations. Surface and crown fire regimes historically interacted to regulate age, landscape, within-stand structure, and succession within this community. Natural fuel breaks imposed by high lake and wetland densities inhibited fire spread within the landscapes this community dominated, resulting in a relatively long fire rotation of 250 years. In northwestern Quebec, Dansereau and Bergeron (1993) similarly found that a large, homogeneous landscape, devoid of lakes, had larger fires and fires of greater intensity compared with a landscape containing numerous water bodies and rough topography. Bergeron (1991) also documented similar traits

for mainland versus islands in a large lake. Fire probability often increased with stand age due to the general increase in fuel (Clark 1989; Heinselman 1973), but individual tree susceptibility to damage or mortality from fire often declined with tree size due to increasing bark thickness and a separation of foliage from the ground, which reduces crown-fire occurrence. This community may have promoted surface fires by forming a deep, well-aerated litter layer of pine needles (McCune 1988). Relatively infrequent surface fires (30 – 50 years) reduced fuel loadings, eliminated living fuel ladders, and promoted widely-spaced trees that became increasingly resistant to crown fires. Surface fires also reduced competition
and succession to more shade-tolerant species. Red-white pine forests were disturbed by large-scale stand-replacing crown fires within rotations of 130 to 260 years (Whitney 1986) in northern Lower Michigan and by relatively frequent surface
fires. In Michigan's Upper Peninsula, Zhang et al. (1999) estimated mixed red–jack–white pine communities burned on 160-year rotations, and red–white pine communities on 320-year rotations. Clark (1990), Heinselman (1981) and Frissel (1973) reported rotations of 135, 180, and 150 years, respectively, for red-white pine communities in Minnesota. Cleland et al. (2004a) estimated crown-fire rotations for the red–white pine community to be 164, 174, and 207 years in northern Lower Michigan, Michigan's Upper Peninsula, and northern Wisconsin, respectively. Longer rotations in Wisconsin are believed to be due to a higher density of lakes and wetlands and resulting smaller surface area of upland landforms. Surface fires burned at 30 to 50 year intervals on these more mesic or protected sites (Clark 1990). The amount of area maintained by surface fire was likely inversely related to area burned. Surface and crown fire regimes historically interacted to regulate age, landscape, within-stand structure, and succession within this community.

Adjacency or Identification Concerns

The natural range of red pine and white pine largely coincides with the extent of the Canadian shield. These pine forests were widespread in the past and included a diverse mixture of hardwood and conifer species including trembling aspen, bigtooth aspen, paper birch, white spruce, black spruce, balsam fir, red maple, and sugar maple.

Scale Description

Sources of Scale Data ☑ Literature ☑ Local Data ☑ Expert Estimate

Landscape must be adequate in size to contain natural variation in vegetation and disturbance regime. Though the virgin stands of red and white pine are greatly reduced from pre-settlement conditions, scattered stands and ecosystems still exist to represent this type. The Boundary Waters Canoe Area Wilderness (BWCAW) is an example along with the national forests in Minnesota, Michigan, and Wisconsin.

Issues/Problems

The VDDT model was modified to increase the probability of wind storm events. Frelich (YEAR??) has documented wind disturbance of catastrophic proportions as occurring on a 1000-2000 year interval. Granted that this may possibly be the landscape level mean, wind events are far more prevalent and occur randomly and with widespread regularity throughout the range of the red and white pine cover type. Thus, using local data, the wind event probability was increased to occur on an approximately 250 year average.

Model Evolution and Comments

Succession Classes

Succession classes are the equivalent of "Vegetation Fuel Classes" as defined in the Interagency FRCC Guidebook (www.frcc.gov).

Class A 5%

Early1 All Structures

Description

Class is typified by barrens dominated by Carex spp., grasses, and herbaceous plants. Trees comprise less than 10% canopy coverage.

Indicator Species* and Canopy Position

PIRE
PIST

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	no data	no data
Tree Size Class	no data	

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

[ ] Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Fuel Model no data

Class B 10%

Early2 Closed

Description

Class is typified by mixed jack pine-red pine-oak stands, and may include red maple and small patches of aspen-birch.

Indicator Species* and Canopy Position

PIRE Mid-Upper
PIST Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	40 %	100 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Medium 9-21" DBH	

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

[ ] Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Fuel Model no data

Class C 25%

Early3 Open

Description

Class is typified by young red pine-white pine stands < 50 years old.

Indicator Species* and Canopy Position

PIRE Mid-Upper
PIST Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Medium 9-21"DBH	

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

[ ] Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Fuel Model no data

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Class D 20 %

Late1 Open

Description

Class is typified by mature red pine-white pine stands (> 50 yrs), maintained by frequent surface fires.

Indicator Species* and Canopy Position

PIRE	Upper
PIST	Upper

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree Medium 10-24m	Tree Tall 25-49m
Tree Size Class	Very Large >33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Class E 40 %

Late1 Closed

Description

Class is typified by mature red pine-white pine stands (> 50 yrs) with significant ladder fuels that result from lack of fire for 30 or more years.

Indicator Species* and Canopy Position

PIRE	Upper
PIST	Upper

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	Max
Cover	40 %	100 %
Height	Tree Medium 10-24m	Tree Tall 25-49m
Tree Size Class	Very Large >33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Disturbances

Non-Fire Disturbances Modeled

- [ ] Insects/Disease
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other:
- [ ] Other:

Historical Fire Size (acres)

Avg: 10000
Min: 1000
Max: 100000

Sources of Fire Regime Data

- [x] Literature
- [ ] Local Data
- [x] Expert Estimate

Fire Regime Group: 3

I: 0-35 year frequency, low and mixed severity
II: 0-35 year frequency, replacement severity
III: 35-200 year frequency, low and mixed severity
IV: 35-200 year frequency, replacement severity
V: 200+ year frequency, replacement severity

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class. All values are estimates and not precise.

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	166			0.00602	30
Mixed	105			0.00952	47
Surface	220			0.00455	23
All Fires	50			0.02009	

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